Table 4.6.6-1. T&C System Parameters

	Satellite Antenna	
Parameter	Ku-Band Pipe	Ku-Band Planar Array
Command Frequency	12.751 GHz	12.752 GHz
Command Data Rate	50 to 1000 BPS	50 to 1000 BPS
Command Data Encoding	FSK	FSK
Command Carrier Modulation	FM	FM
Command EIRP	83.8 dBW	83.8 dBW
Telemetry Frequency	10.701 & 10.702 GHz	10.701 & 10.702 GHz
Telemetry Data Rate	1000 or 4000 BPS	1000 or 4000 BPS
Telemetry Data Encoding	BPSK	BPSK
Telemetry Subcarrier Frequency	32 kHz	32 kHz
Telemetry Modulation	PM, 1 radian	PM, 1 radian
Satellite Telemetry EIRP	0.0 dBW	8.0 dBW
Ranging Accuracy On-Station	30 meters	30 meters

The TT&C ground stations will use 7-meter Ku-band antennas to control and monitor the satellites. A number of additional ground antennas will be provided for redundancy and backup. The 7-meter antennas will be equipped with 90°K low noise amplifiers (LNA) which will provide a G/T of 34.2 dB/K. They will have 600 Watt high power amplifiers (HPA), which will provide an effective isotropic radiated power (EIRP) of 83.8 dBW.

The satellite command receive system noise temperature will be 900°K, and the satellite transmit power for telemetry will be 8 dBW. The satellite command receiver requires an input power of -135 dBW for command execution. With a nominal ground station EIRP of 83.8 dBW, the command threshold requirements are met through the planar array and omni antennas. Appendix A provides on-station command and telemetry link budgets.

4.6.6.1. Telemetry

The telemetry subsystem will have two identical links consisting of two encoders that modulate either of two transmitters via a cross-strap switch. Data pertaining to unit status, satellite attitude, and satellite performance will be transmitted continuously for satellite management and control. The telemetry transmitter will also serve as the downlink transmitter for ranging tones and command verification. The telemetry data mode will be PCM. For normal on-station operation, the telemetry transmitters will be connected via a filter to the transmit feeds of the Ku-band communications antennas.

In transfer orbit, each telemetry transmitter will drive one of two Ku-band communication TWTAs selected to provide adequate EIRP for telemetry coverage via the bicone or pipe antennas. Selection of this mode, which is also used for emergency backup to normal on-station operation, will be by ground command or SCP fault logic.

4.6.6.2. Command

The command subsystem will control satellite operation through all phases of the mission by receiving and decoding commands to the spacecraft. Additionally, it will enable the uplink receiver to process ranging signals and provide closed loop tracking of the command uplink for satellite antenna pointing. It will perform the latter function without interfering with the command function. The command uplink will employ government-approved command encryption. The command signals will be fed through a filter diplexer into a redundant pair of track command receivers. The composite signal of the receivers' total output will drive a pair of redundant decoders. The decoders will provide command outputs for all satellite functions.

The planar array will be used for on-station command, ranging, and satellite tracking of the command uplink. The omni antenna will be used for transfer orbit command and ranging and for emergency backup.

4.6.6.3. Tracking Beacons

Beacon tracking will be provided at both Ku-band and V-band. The beacons will enhance satellite attitude control and pointing and will be tracked on the ground by two tracking stations. A monopulse technique will be used. Tracking beacon frequencies will be located at lower edges of the communications bands. There will be two transmit and two receive beacons (one per polarization) at Ku-band and two transmit and two receive beacons (one per polarization) at V-band.

4.6.7. Intersatellite Links

ISLs will be used to interconnect the SpaceCast™ satellites. A laser communication subsystem will be used to provide all ISLs. Selected outputs of the on-board TDMA switch will be routed to the laser payload, where the data will be frequency converted and multiplexed to provide a maximum 3 Gbps data rate for intersatellite connectivity. The laser ISL system will operate at a wavelength in the 1.55 micron region.

4.7. Number of Satellites

SpaceCast™ is comprised of six technically identical satellites at four orbital positions. There will be two satellites in each of the 60° W and 125° W orbital positions. There will be one satellite in each of the 155° E and 39° W orbital positions. Each satellite is technically identical, capable of using the same frequency bands, and is designed to support on-orbit antenna beam reconfiguration for maximum flexibility of service. On-orbit antenna beam reconfiguration is chosen so that satellites can be adjusted to meet changing user demand.

4.8. ORBIT CONSIDERATIONS

The selection of orbital positions for the SpaceCast™ system was based on the following considerations: (1) the orbital positions must be capable of accommodating both V-band and Ku-band operations; (2) the orbital positions must support service for, to, and from the United States, (3) ground terminal elevation angles to SpaceCast™ must be 15 degrees or greater; and (4) the presence or absence of other proposed or deployed satellite systems.

4.9 SATELLITE OPERATIONAL LIFETIME

The SpaceCast™ satellite is designed to meet all specified operational requirements for a 15 year period in orbit. A small degradation in performance is expected after this time. This lifetime has been determined by a conservative estimate of the effect of a synchronous orbit environment on the solar array, battery charge/discharge cycling, and TWT wear. The propellant remaining after transfer orbit allows station keeping for 15 years. The propellant required for on-station positioning is governed by north/south inclination requirements, orbital position change, and de-orbit requirements.

All critical electronics and components employ redundant units. For TT&C, a two-for-one redundancy is typically required. The satellite electrical design follows well established criteria in part selection. Hardware is based on existing units which have already experienced successful missions after years in orbit.

The on-board Xenon Ion Propulsion System (XIPS) fuel reserve will be used to place the satellite in a supersync orbit at the satellite end-of-life.

4.10. Earth Segment

4.10.1. Satellite Command and Control

Command and control of SpaceCast™ satellites will be performed via Satellite Control Facilities (SCF) as illustrated in Figure 4.10.1-1. TT&C will take place at Ku-band using a portion of the requested spectrum at the lower edges of the bands. Each SCF station will be linked to an Operations Control Center (OCC). This center will also be responsible for the command and control of all SpaceCast™ satellites. TT&C link performance and parameters are given in Appendix A.

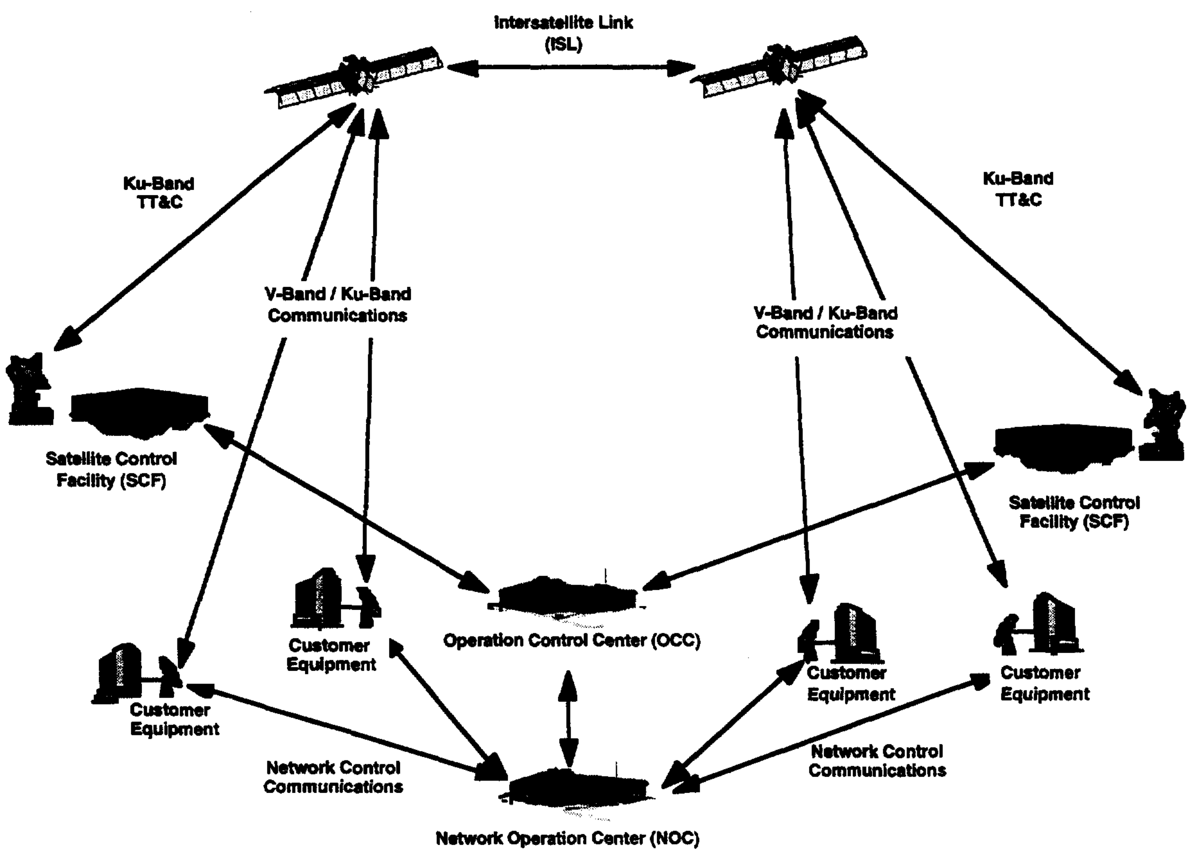

Figure 4.10.1-1. Example of SpaceCast™ Satellites and Earth Segment

4.10.2. Payload Management

Operation and management of SpaceCast™ communications system resources will be performed from a Network Operation Center (NOC). The NOC will manage all communications functions including broadcast routing, initiation, teardown, and customer interfacing including service requests and billing. This center will maintain communications with customer equipment. It will be responsible for keeping track of all connections and management of system resources. It will monitor service quality in conjunction with monitoring equipment located at a number of sites within each of the satellite's coverages. Finally, it will provide and maintain the TDMA circuit switch routing table that is uploaded to the satellite onboard processor via the Ku-band TT&C link. The routing table will control all circuit connections and traffic through SpaceCast™'s V-band and Ku-band links as well as its ISLs.

4.10.3. Customer Equipment

The services offered by SpaceCast™ will be provided at a burst rate of up to 155 Mbps (OC-3). SpaceCast™ offers a decentralized uplinking approach, thereby allowing users to directly access the satellites from their facilities. Some customers will have single frequency mode (either V-band or Ku-band) terminals. Others will have dual frequency mode (V-band and Ku-band) terminals that will allow switching between V-band and Ku-band operations. Ku-band coverage will be available both inside and outside of the V-band spot beam coverage areas.

Users with uplinking capabilities will use 2.5 meter two-way terminals. They will use 50 Watt V-band and 50 or 100 Watt Ku-band TWTAs and burst at 155 Mbps (see link budget in Appendix A).

Receive-only users will either use a 45 cm or 100 cm (18 inch or 39 inch) terminal. One meter terminals will support the 155 Mbps data rate. Smaller V-band receive-only terminals will provide service at a lower data rate.

Figure 4.10.3-1 describes the family of SpaceCast™ terminals.

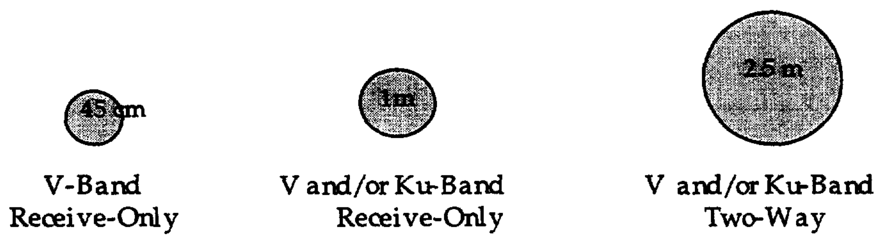

Figure 4.10.3-1. Family of Terminals

To the extent that the 13.75 - 14.0 GHz band is used for uplinks to SpaceCast™, due consideration will be given to the earth station size and power limits that are imposed on use of this band by FCC Rules and the international Radio Regulations.

4.11 Link Availability

4.11.1. Rain Effects

SpaceCast™ will take a system approach to provide availability. V-band coverage areas will have continuous monitoring terminals. These monitoring sites will send link quality messages to the SpaceCast™ SOC and NOC. If necessary, the satellite and customer equipment can be commanded to provide service via the Ku-band payload to dual band receivers.

Link availability analyses were performed for several cities around the world. The results of these analyses based on a 95% availability at V-band, appear in Table 4.11.1-1.

Table 4.11.1-1. V-Band Design Margins for Rain in Various Cities

Country	City	Rain Loss Margin (in dB) for 95% link availability	
		Space-Earth	Earth-Space
China	Beijing	1.5	1.8
Japan	Tokyo	2.0	2.4
UK	London	2.2	2.9
US	Chicago	2.2	2.8
US	Dallas	3.1	3.6
US	Los Angeles	1.4	1.7
US	New York	2.5	3.1

4.11.2. Cloud and Gaseous Effects

Because the additive effect of rain attenuation and cloud and gaseous effects at low elevation angles would degrade link availability unacceptably, the SpaceCast™ design generally restricts the minimum user operating elevation angle to 30° or higher in Asia, 20° in the Pacific Islands and in the U.S., and 15° in Europe.

4.12. LAUNCH SEGMENT

Specific launch services have not been selected at this time. The SpaceCast™ bus is compatible with a variety of commercially available launch vehicles.

5. INTERFERENCE ANALYSIS

5.1. SpaceCast™ System Spectrum

The SpaceCast™ Earth-to-space service links will operate at 47.2-50.2 GHz and on 500 MHz of bandwidth that is allocated for FSS uplinks within the frequency range 12.75-13.25 GHz and 14.0-14.5 GHz. The space-to-Earth service links will operate at 39.5-42.5 GHz,[4] and on 500 MHz of bandwidth that is allocated for FSS downlinks within the frequency range 10.7-12.75 GHz.[5]

At Ku-band, the 12.75-13.25, 10.7-10.95 and 11.2-11.45 GHz bands are planned for worldwide use under Appendix 30B of the international Radio Regulations.[5] The primary purpose of the GSO FSS Plan associated with Appendix 30B is to

[4] In IB Docket 97-95, the Commission is currently considering various options with respect to the 36-51.4 GHz bands including the addition of FSS allocations at 40.5-42.5 GHz. The V-band frequencies requested for SpaceCast™ were chosen to reflect the current HCI position regarding the NPRM as presented in HCI's Reply Comments submitted June 3, 1997 (IB Docket 97-95). HCI respectfully reserves the right to conform this application to reflect the outcome of that proceeding and/or any changes in the international Radio Regulations. The Commission's Public Notice establishing a cut-off for additional applications in the 36-51.4 GHz frequency band, DA 97-1551 (July 22, 1997), states that: "Applicants filing by the cut-off date will be afforded an opportunity to amend their applications, if necessary, to conform with any requirements and policies that may be adopted subsequently for space stations in these bands."

[5] The 10.7 - 10.95 GHz, 11.2 - 11.45 GHz and 12.75 - 13.25 GHz bands already have been allocated by the Commission for FSS. See 47 C.F.R. § 2.106. HCI's proposed use of these bands by the SpaceCast™ system (as well as 10.95 - 11.2 GHz and 11.45 - 11.7 GHz) is fully consistent with footnote NG 104, which limits use of all those bands to international (i.e., other than domestic) systems. The commission has previously licensed FSS use of these planned bands for an international satellite system. *See PanAmSat Licensee Corp.*, DA 96 -2124 (released December 17, 1996). To the extent necessary, HCI requests a waiver of the application of NG 104 to this application and will provide whatever supplemental supportive materials that the Commission may require. As demonstrated in this Section 5, SpaceCast™ will adequately protect existing terrestrial services in the 10.7-11.7 GHz downlink band by complying with existing PFD limits, and will adequately protect existing terrestrial services in the 12.75-13.25 GHz uplink band by coordinating SpaceCast™ uplinks with those users where appropriate.

accommodate national satellite communications systems, but the provisions of the Appendix are flexible enough to permit Administrations to submit filings for systems which are not already defined in the Plan. These systems may be assigned orbital positions under the Plan provided that harmful interference will not result between such a system and any satellite network that is defined in the Plan and brought into operation by an administration and provided that displacements of any national allotments under the plan are agreed to by affected Administrations. Article 6, Section III of Appendix 30B includes a procedure for the use of these bands for purposes other than national coverage.

The SpaceCast™ system requires the bandwidth requested in this application in order to offer video and multimedia services to prospective customers within the international service area of the system. HCI believes that the types of services proposed in this application fall within the definition of the "broadcasting satellite service" for which the 40.5-42.5 GHz band already is allocated, as well as within the definition of FSS. HCI has separately urged the Commission to support changes in the international Radio Regulations to allow worldwide FSS operation in the 40.5-42.5 GHz band that is currently allocated to the BSS. In the event that FSS use is not permitted in that part of the band and it is determined that the SpaceCast™ services do not also fall within the definition of BSS, HCI intends to specify alternate spectrum for SpaceCast™ in part of the 36.0-51.4 GHz band that is allocated for FSS.

In addition to the service links, SpaceCast™ will use optical ISLs in the range of 1.55 micron wavelength. The command links will operate in 1.5 MHz near the lower edges of the Ku-band Earth-to-space frequencies. The telemetry links will operate in 1.5 MHz near the lower edges of the Ku-band FSS space-to-Earth frequencies. The receive beacons will operate in 100 kHz near the lower edges of the Ku-band and 47.2-50.2 GHz Earth-to-space frequencies. The transmit beacons will operate in 100 kHz near the lower edges of the Ku-band and 39.5-42.5 GHz space-to-Earth frequencies.

5.2. Interference and Sharing Analysis

5.2.1. Intra-Service Interference and Sharing

5.2.1.1 Fixed-Satellite Service

Interference between SpaceCast™ and other FSS systems can be divided into two basic classes – interference between GSO systems and interference between NGSO and GSO systems. The case of interference between GSO systems will be treated first. The main issue pertaining to SpaceCast™ and other GSO systems in the same frequency bands and coverage regions is whether or not there is sufficient orbital spacing between satellites of the respective systems to mitigate harmful interference. If the satellites are placed too close to each other, excessive interference will result. The 2° orbital separation commonly used for GSO FSS satellites will be adequate for SpaceCast™ satellites to share spectrum at V-band with other GSO satellites. An interference analysis demonstrating this capability is contained in Appendix B.

The Ku-band frequencies to be used by SpaceCast™ may include bands allotted for national or subregional use under Appendix 30B of the international Radio Regulations. In that event, SpaceCast™ will coordinate with other GSO systems operating in the bands pursuant to Appendix 30B to the extent provided under that

Appendix. The 2° orbital separation commonly used for GSO FSS satellites will be adequate for satellites operating in the Ku-band. An interference analysis demonstrating this capability is contained in Appendix B.

The ground tracks of NGSO satellites do not remain stationary over a single point on the Earth. Instead, they produce multiple ground tracks between north and south latitudes determined by the inclination of the satellite. Therefore, there is a potential for interference with GSO satellite networks when the GSO and NGSO systems share frequency bands and polarization. NGSO satellite systems can use interference mitigation techniques, such as satellite diversity and avoidance of pointing at the geostationary arc, to avoid excessive interference with GSO operations. A number of domestic and international NGSO satellite networks, such as Celestri, SkyBridge, and F-SATMULTI 1A/B, have proposed such sharing techniques.

5.2.1.2 Inter-Satellite Service

SpaceCast™'s intersatellite service operates via an optical ISL which uses lasers of extremely narrow beamwidths. This ensures that satellite receivers outside of a narrow optical path will avoid harmful interference. The narrow beamwidths also prevent, as a practical matter, other satellites from blocking the line-of-sight of its ISL. For these reasons, and because the orbital positions and/or orbital parameters may differ between systems, the possibility of harmful interference occurring between ISLs is negligible. Therefore, common use of the same optical wavelength (1.55 micron) on all SpaceCast™ satellites is an efficient, practical method of achieving high bandwidth ISLs.

5.2.2. Inter-Service Interference and Sharing

5.2.2.1 Radio Astronomy Service

Radiotelescopes use the 48.94-49.04 GHz band for spectral line observations. The potential for harmful interference from SpaceCast™ to the radio astronomy service is quite low because (1) the listed frequencies are located within a band that SpaceCast™ uses for Earth-to-space links, and (2) the SpaceCast™ earth station antennas will have very narrow beamwidths. Therefore, SpaceCast™ should be able to share the 48.94-49.04 GHz band with the radio astronomy service.

5.2.2.2 Terrestrial Services

Coordination may be necessary between terrestrial microwave stations and SpaceCast™ user terminals to avoid harmful interference. SpaceCast™ user terminals will operate in accordance with Sections 25.204 and 25.209 of the Commission's Rules to minimize radiating harmful interference into terrestrial microwave services. Also, SpaceCast™ will operate in accordance with international Radio Regulations S21.6, S21.8, S21.9, and S21.12 as applicable, so harmful interference to terrestrial microwave stations can be minimized.

Likewise, harmful interference from SpaceCast™ space station transmitters into a terrestrial receiver is possible if a SpaceCast™ space station does not limit its PFD as applicable in the frequency band affected. However, SpaceCast™ space stations will operate in accordance with Section 25.208 of the Commission's Rules and with international Radio Regulation S21.16, as applicable, to minimize harmful interference to terrestrial services.

Harmful interference into SpaceCast™ space station receivers from terrestrial microwave transmitters is unlikely due to the high space loss and atmospheric attenuation in the Earth-to-space bands that SpaceCast™ will use. However, excessive interference into SpaceCast™ space station receivers from Earth station transmitters of stratospheric fixed service systems, such as SkyStation, is possible if suitable EIRP limits are not imposed upon those transmitters.[6]

5.2.2.3 Earth Exploration-Satellite and Space Research Services

The EESS and SRS have primary international allocations at 40.0-40.5 GHz (Earth-to-space). The main source of interference will be from EESS and SRS earth station transmitters to SpaceCast™ earth station receivers. SpaceCast™ will coordinate with stations in the EESS and SRS to minimize interference to its space-to-Earth links.

Stations in the SRS operating at 13.75-14.0 GHz that received authorization to operate from the commission on or before January 31, 1992 are assigned frequencies on a co-primary basis with stations in the FSS so long as such stations in the SRS continue in service. Until January 1, 2000, EESS and SRS NGSO space stations operating at 13.75-14.0 GHz are assigned frequencies on a co-primary basis with stations in the FSS.

[6] In its Second Report and Order in ET Docket No. 94-124, RM-8308, 8784 (released July 21, 1997), the Commission designated the 47.2-48.2 GHz for wide-area licensing, but has not yet established the terms for licensing this band or for sharing the band among different users.

HCI will work with EESS and SRS station operators on a case-by-case basis to resolve any coordination issues that may arise between SpaceCast™ and stations operating in these services.

5.2.2.4 Radiolocation and Radionavigation Services

The radiolocation service has co-primary U.S. and international allocations with the FSS at 13.75-14.0 GHz. The radionavigation service has a co-primary U.S. allocation with the FSS at 14.0-14.2 GHz, and a co-primary international allocation with the FSS at 14.0-14.3 GHz. Unlike the terrestrial services considered previously, operations in the radiolocation or radionavigation services may occur at any elevation angle due to radar and direction-finding transmissions from or to aircraft. HCI will work with operators of these services to resolve any coordination issues concerning emissions in these bands, as necessary and applicable, where both FSS and either the radiolocation or the radionavigation services have co-primary frequency allocations.

5.2.2.5 Broadcasting-Satellite Service

The FSS has a primary international allocation for space-to-Earth emissions at 12.5-12.75 GHz in Region 3, and so does the BSS pursuant to Resolution 33 from WARC-79. Because SpaceCast™ may operate at 12.5-12.75 GHz for space-to-Earth emissions in Region 3, HCI will resolve any coordination issues with stations operating in the BSS at 12.5-12.75 GHz on a case-by-case basis.

5.3. Spurious and Out-of-Band Emissions

SpaceCast™ will comply with the emission limitations specified in Section 25.202(f) of the Commission's rules.

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Regulatory Qualifications

6. REGULATORY QUALIFICATIONS

6.1 LEGAL QUALIFICATIONS

HCI's legal qualifications are a matter of record before the Commission, and HCI will provide any additional information regarding its legal qualifications that the Commission may require.

6.2 COMPLIANCE WITH INTELSAT ARTICLE XIV

HCI recognizes that the SpaceCast™ system may be subject to consultation requirements under Article XIV of the INTELSAT Agreement and will provide appropriate information to facilitate any such consultations.

6.3 NON-COMMON CARRIER STATUS

To the extent that HCI provides SpaceCast™ service directly to end users, HCI intends to operate the majority of the SpaceCast™ capacity on a non-broadcast, non-common carrier basis, in substantially the same manner that DBS and DTH service is provided today by other service providers. To the extent that HCI sells or leases SpaceCast™ capacity to its customers for their own transmissions, HCI will do so on an individualized basis and will not hold itself out to serve the public indiscriminately. In accordance with the Commission's DISCO I Report and Order, 11 FCC Rcd. 2429, 2436 (1996), and Section 25.114(c)(14), HCI elects to offer the entire capacity of the SpaceCast™ system on a non-common carrier basis.

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7. MILESTONE SCHEDULE

HCI proposes to implement the SpaceCast™ system according to the following plan. The dates by which the following goals are scheduled to be achieved are as follows.

Table 7-1. SpaceCast™ Major Milestones

Milestone	Milestone Completion (Months After Authority to Proceed)
Commence construction of first satellite	ATP + 12
Construction of first satellite complete	ATP + 44
First satellite launch	ATP + 45
First satellite in service	ATP + 48
Subsequent satellites	Every 6 months thereafter

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8. PROJECTED SYSTEM COST

Table 8-1 provides the estimated capital investment and first year operating expenses for SpaceCast™. The capital expenditure for space and ground segments is projected to be $1.635 billion, which includes the construction cost of the satellite and the respective launch vehicle service, launch insurance, and associated ground equipment costs. Satellite costs are derived estimates from the manufacturer, Hughes Space and Communications Company, a unit of Hughes Electronics Corporation. The costs of the launch vehicle and other associated items are based on industry practice. The ground segment costs are based on projected costs for modification of existing Network Operation Control Centers and TT&C Earth stations. Customer equipment costs are not included as part of that equipment cost.

Table 8-1. SpaceCast™ Investment

Capital Expenditures	$M
• Spacecraft (6), launch and insurance	$1,545
• Satellite Control	45
• Network Operations & Control	20
• Customer Equipment Development	25
	$1635
First year operating cost	45
Total	$1680